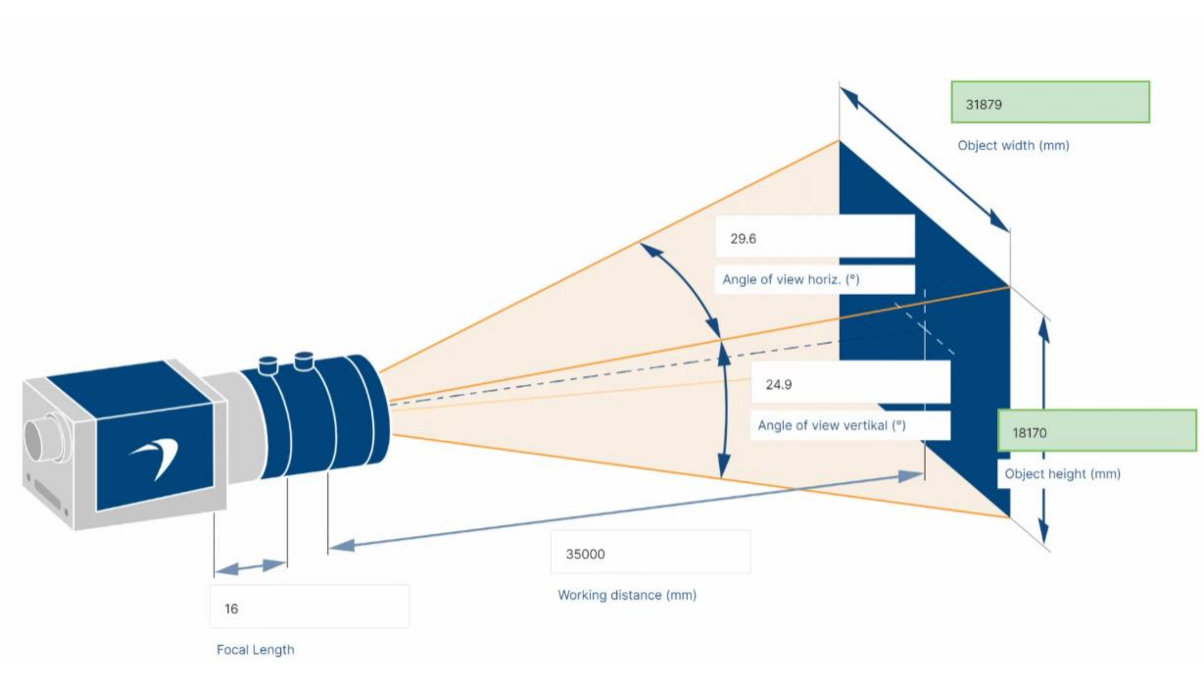
Sapienza Flight Team SUAS 2024

ODLC:

Camera: Busler a2A5320-23ucBAS for its lightweight, small pixel size and high sensor regulation ensuring it is the overall best choice for the competition.

	Basler a2A5320-23ucBAS	Daheng imaging MER2-503-36U3C	Sony A6000
Sensor size	14.58 mm × 8.31 mm	8,8 mm	23,5 x 15,6 mm
Pixel size	2.74 µm	3,45 µm	3.88 µm
Sensor resolution	5320 px x 3032 px	2448 px x 2048 px	4240 px x 2832 px
Field of view @ 35m	31 m x 18m	26m x 22 m	28 m x 25 m
Lens	16mm	12mm	35mm
MP	16.1MP	5 MP	24,3 MP
Weight	121 g	132g	586g
Pixel density	1.98px/cm	1.02px/cm	1.56px/cm
others considerations	New gen Sony sensor, extremely compact and easy to program	Old gen Sony sensor, extremely compact	Not made for this use, bulky and not optimized to communicate with jetson

Shooting was done at approximately 120ft to maximize capture area and guarantee best recognition performance

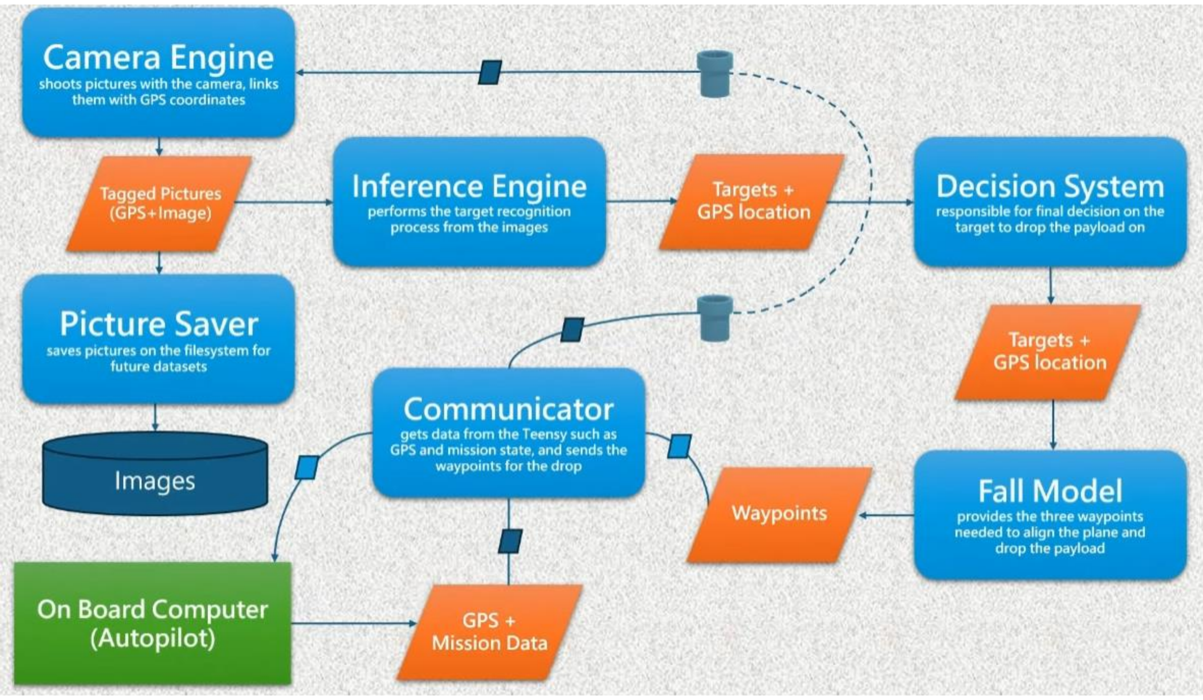


On-board computer: jetson AGX ORIN 64GB which has 64GB of video memory along with a powerful GPU ensuring the ODLC process runs smoothly and efficiently

	Jetson Orin Nano 8GB	Jetson AGX Orin 64GB
AI Performance	40 TOPS	275 TOPS
GPU	1024-core Ampere, with 32 Tensor Cores	2048 Core Ampere, with 64 Tensor Cores
CPU	6-core Arm® Cortex®-A78AE	12 core Arm® Cortex®-A78AE
Memory	8GB	64GB
Weight	176 grams	528 grams
Power	15W	15W, 30W, and 65W
ZED capable, obstacle avoidance	Yes standard mode	Yes, ultra/neural mode
ODLC Performance	Slower	Extremely faster, allowing to implement larger and more accurate model

ODLC process:

Camera engine transmits tagged pictures to be saved and into the inference engine to start the target recognition process. Inference engine transmits the target data along with the GPS location to the decision-making software where the final say on where to drop the payload is made. The decision system then transmits to the Fall model which provides the waypoint which are then relayed to the communicator



- results are fed to Yolo models for colour detection then to a fine-tuned S NET classifier for character detection

For target detection several models were used including Yolo NAS, Yolo v8l, and Yolo v8m all trained using a test train validation split of a 40,000 real image dataset, an additional 50,000 synthetic images were used to further train the models.

Yolo NAS is used to detect old features at the same time while an assemble of 3 different models is used, each used to detect different object features (shape, colour, character). This approach increases the scalability of the model by reducing the total classes resulting in a denser dataset overall.

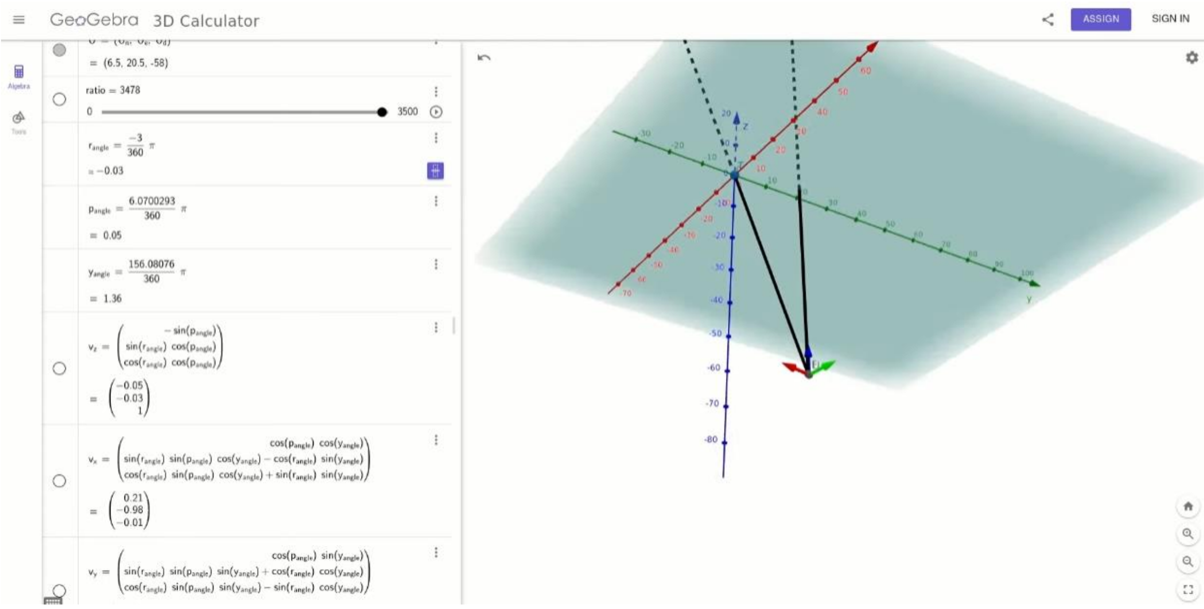
ODLC PERFORMACE COMPARISON

	YOLOv8m	YOLOv8l	YOLOv8m	YOLOv8l	YOLOv8m	YOLOv8l	CNN
Table	Splitted characters		Splitted shape		Splitted color		Emnist
mAP [%]	75	76	78.8	79.4	80.4	80	85
Recall [%]	73.5	75.1	75.8	77.6	80.3	79.8	84.1
Precision [%]	79.3	80	86.2	86.1	86.3	85.8	86

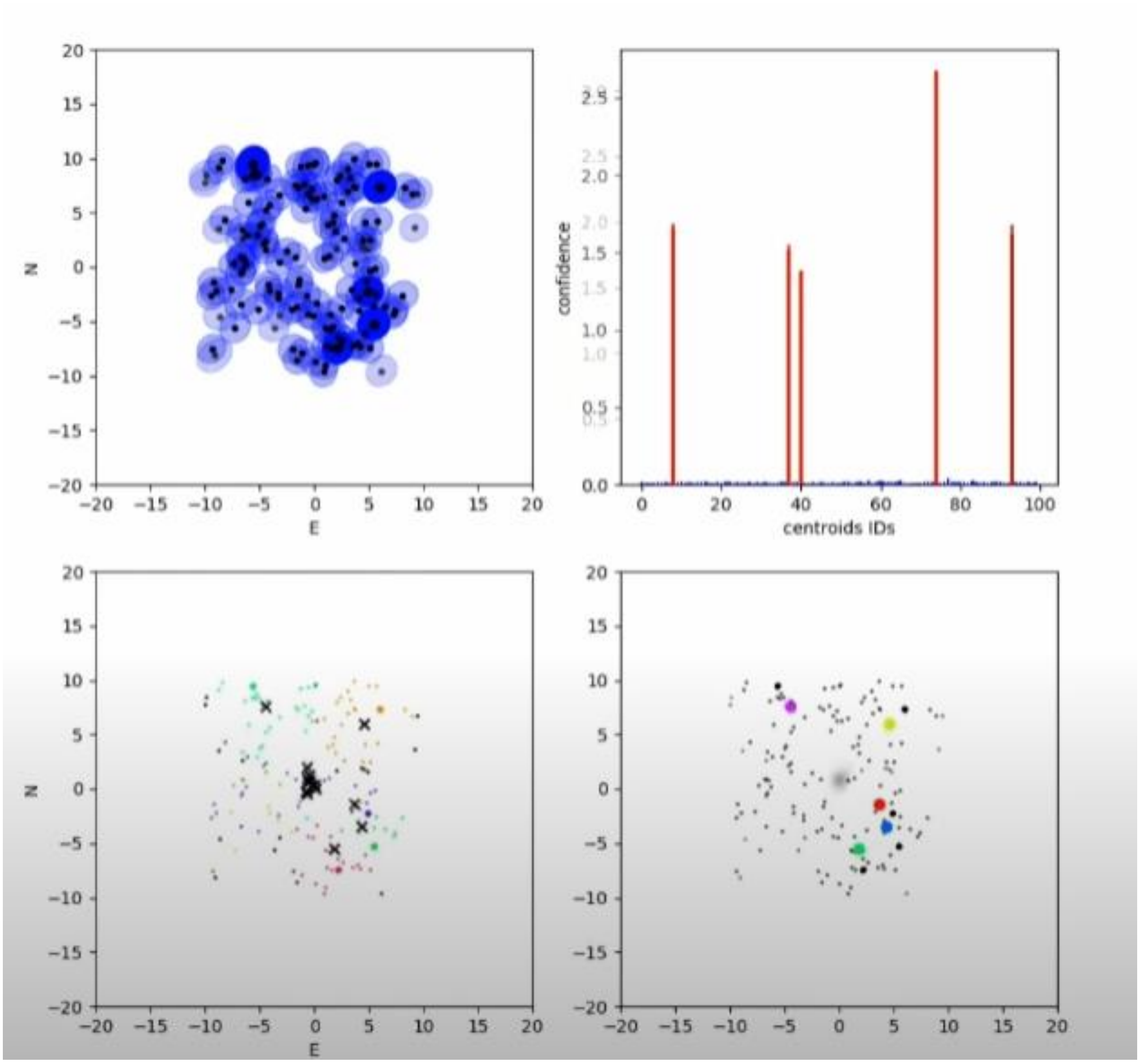
Localization:

decision system: confidence level extracted from the yolo models along with information about the five targets help the decision system

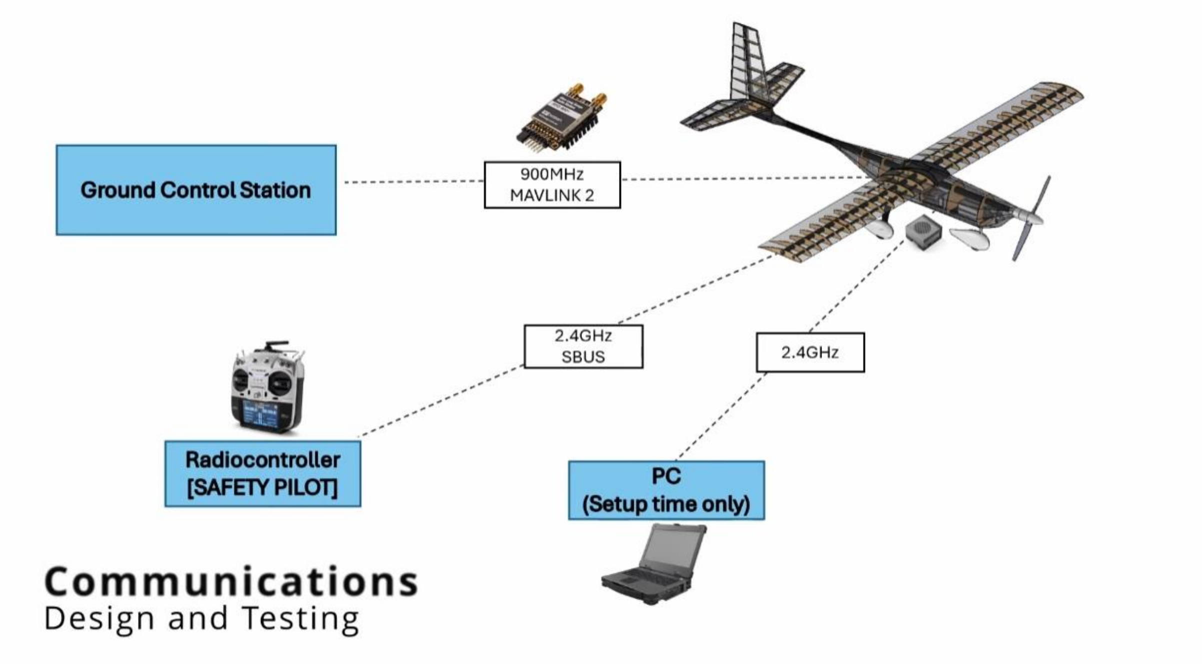
GeoGebra software is used for localization by utilizing variables such as longitude and latitude of aircraft, position of camera relative to the aircraft and camera specs to accurately determine location of targets. After testing, the team concluded that lens deformation is not significant compared to measurement errors



And so, by utilizing estimates of measurement errors provided by Geolocation, Mathematical models such as monte Carlo and maximum likelihood estimation are used which yield an empirical error of 16 inches after testing. This high accuracy ensures that the localization system can function completely autonomously

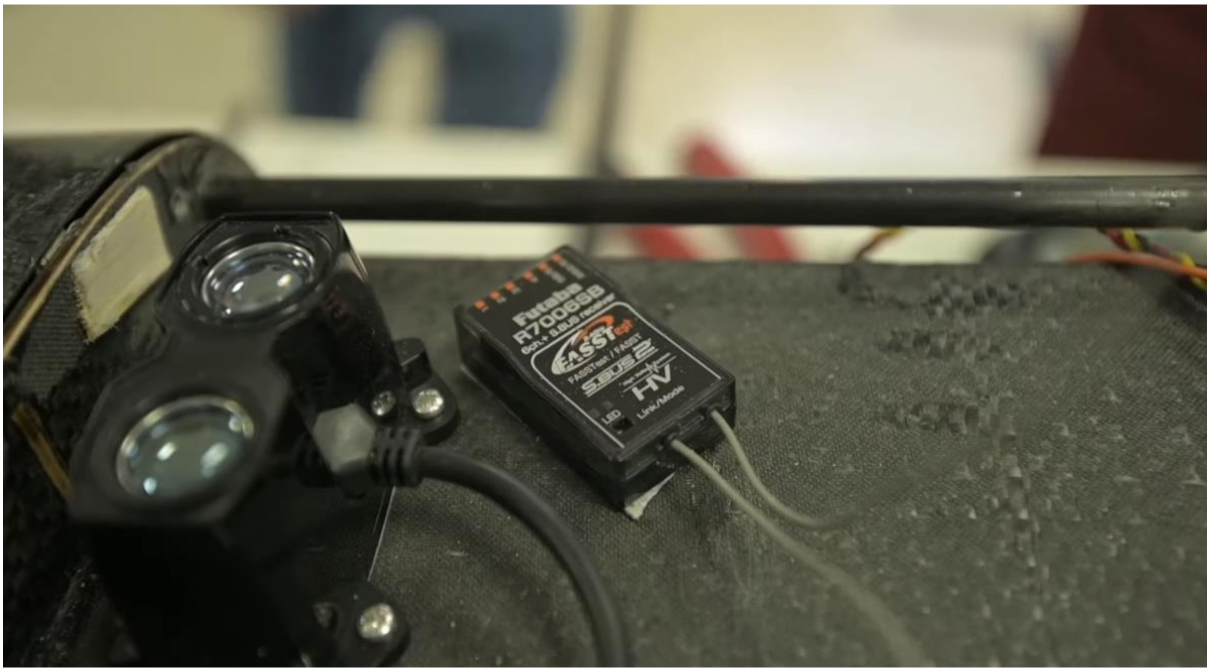


Communication system:



communication system between UAV and GCS consists of two rfd900x US modules with a 3dbi omnidirectional antenna on the drone and a custom 10dbi antenna on the ground mounted to a fixed strip near the GCS

A secondary link is used consisting of a 2.4GHz BUS protocol receiver that connects the drone to the remote controller and the GCS operated by the safety pilot. This system is used in case of complete failure of the autopilot system



Communication with the autopilot is based on the MAVLINK protocol connecting the drone to a laptop and radio modem on the ground.

The frontend interface is a modified version of Q ground control that displays mission plans and boundaries, performs telemetry and transmits messages to the drone

Communication to the jetson on-board computer during setup time is done through a 2.4 GHz link through a computer that was tested extensively on the team's airfield while several other UAVs were airborne on the same airfield using various frequencies

Wi-Fi system not present

UBC Uncrewed Aircraft Systems Wi-Fi system:

A high bandwidth image telemetry system operating in the 5.8GHz range is achieved using standard Wi-Fi equipment and transmits using the U-NII3 band

- 6dbi antenna is used on the drone
- 22dbi antenna is used on the ground

The system is expected to run a 30Mbps data stream across a 2km range. System was not tested at full gain due to location constraints but a test was made at 6 of 22 dbi of gain across 6m providing a data stream of 60Mbps using TCP protocol. Calculations expect system to run at 60Mbps across 380m using a 22dbi antenna